WHAT IS CLAIMED IS:

1. (Original) A desulfurization unit employing fluidizable and circulatable solid particles to remove sulfur from a hydrocarbon-containing feed, said desulfurization unit comprising:

a fluidized bed reactor;

a fluidized bed regenerator; and

a fluidized bed reducer close-coupled to said reactor.

2. (Original) The desulfurization unit of claim 1, further comprising a reactor stripper close-coupled to said reactor.

3. (Original) The desulfurization unit of claim 1, further comprising a regenerator receiver close-coupled to said regenerator.

4. (Original) The desulfurization unit of claim 1, wherein said reducer defines a reducer solids outlet and said reactor defines a reactor solids inlet, wherein said reducer solids outlet and reactor solids inlet are spaced less than about 10 feet from one another.

5. (Original) The desulfurization unit of claim 4, wherein said reducer solids outlet and said reactor solids inlet are spaced less than 5 feet from one another.

6. (Original) The desulfurization unit of claim 1, further comprising a first transport assembly for transporting said solid particles from said reactor to said regenerator and a second transport assembly for transporting said solid particles from said regenerator to said reducer.

7. (Original) The desulfurization unit of claim 6, wherein said first transport assembly includes a reactor stripper, wherein said reactor defines a reactor solids outlet and said reactor stripper defines a stripper solids inlet, wherein said reactor solids outlet is close-coupled to said stripper solids inlet.

8. (Original) The desulfurization unit of claim 7, wherein said reactor solids outlet and said stripper solids inlet are spaced less than about 10 feet from one another.

9. (Original) The desulfurization unit of claim 8, further comprising a reactor close-coupling conduit fluidly coupling said reactor solids outlet to said stripper solids inlet, said reactor close-coupling conduit defining a substantially straight open passageway extending from said reactor solids outlet to said stripper solids inlet.

10. (Original) The desulfurization unit of claim 9, wherein said open passageway has a minimum flow path area of at least about 10 square inches.

11. (Original) The desulfurization unit of claim 9, wherein said open passageway extends substantially horizontally.

12. (Original) The desulfurization unit of claim 6, wherein said second transport assembly includes a regenerator receiver, wherein said regenerator defines a regenerator solids outlet and said regenerator receiver defines a receiver solids inlet, wherein said regenerator solids outlet is close-coupled to said receiver solids inlet.

13. (Original) The desulfurization unit of claim 12, wherein said regenerator solids outlet and said receiver solids inlet are spaced less than about 10 feet from one another.

14. (Original) The desulfurization unit of claim 13, further comprising a regenerator close-coupling conduit fluidly coupling said regenerator solids outlet to said receiver solids inlet, said regenerator close-coupling conduit defining a substantially straight open passageway extending from said regenerator solids outlet said receiver solids inlet.

15. (Original) The desulfurization unit of claim 14, wherein said open passageway has a minimum flow path area of at least about 10 square inches.

16. (Original) The desulfurization unit of claim 14, wherein said open passageway extends substantially horizontally.

17. (Original) The desulfurization unit of claim 6, further comprising a reducer close-coupling conduit for transporting said solid particles from said reducer to said reactor, said reducer close-coupling conduit defining a substantially straight open passageway extending from said reducer to said reactor.

18. (Original) The desulfurization unit of claim 17, wherein said open passageway extends from said reducer to said reactor at a downward angle in the range of from about 15 to about 75 degrees from horizontal.

19. (Original) The desulfurization unit of claim 17, wherein said open passageway defined by said reducer close-coupled conduit extends less than about 10 feet, wherein said open passageway has a minimum flow path area of at least about 10 square inches.

20. (Original) The desulfurization unit of claim 6, wherein said first transport assembly includes a reactor stripper vertically positioned along side said reactor, a reactor lockhopper vertically positioned lower than said reactor stripper, and a regenerator feed surge vessel vertically positioned than said reactor lockhopper.

21. (Original) The desulfurization unit of claim 20, wherein said first transport assembly includes a pneumatic lift operable to dilute phase transport said solid particles upward from said regenerator feed surge vessel to said regenerator.

22. (Original) The desulfurization unit of claim 6, wherein said second transport assembly includes a regenerator receiver vertically positioned alongside said regenerator and a regenerator lockhopper vertically positioned lower than said regenerator receiver.

23. (Original) The desulfurization unit of claim 22, wherein said reducer is vertically positioned lower than said regenerator lockhopper.

24. (Original) The desulfurization unit of claim 22, wherein said regenerator receiver defines a solids inlet and a fluids outlet, wherein said solids inlet and said fluids outlet are separate from one another, wherein said solids inlet and said fluids outlet are both fluidly coupled to said regenerator.

25. (Original) A desulfurization unit employing fluidizable and circulatable solid particles to remove sulfur from a hydrocarbon-containing feed, said desulfurization unit comprising:

a reactor having a reactor solids inlet and a reactor solids outlet;

a regenerator having a regenerator solids inlet and regenerator solids outlet;

a reducer having a reducer solids inlet and a reducer solids outlet;

a first transport assembly for transporting said solid particles from said reactor solids outlet to said regenerator solids inlet;

a second transport assembly for dense phase transporting said solid particles from said regenerator solids outlet to said reducer solids inlet; and

a third transport assembly for transporting said solid particles from said reducer solids outlet to said reactor solids inlet.

26. (Original) The desulfurization unit of claim 25, wherein said reactor solids outlet is vertically positioned higher than said reactor solids inlet, wherein said regenerator solids outlet is vertically positioned higher than said regenerator solids inlet, wherein said reducer solids outlet is vertically positioned higher than said reducer solids inlet.

27. (Original) The desulfurization unit of claim 26, wherein said regenerator solids outlet is vertically positioned higher than said reducer solids inlet.

28. (Original) The desulfurization unit of claim 27, wherein said reducer solids outlet is vertically positioned at least at high as said reactor solids inlet.

29. (Original) The desulfurization unit of claim 25, wherein said third transport assembly is operable to dense phase transport said solid particles from said reducer to said reactor.

30. (Original) The desulfurization unit of claim 25, wherein said first transport assembly includes a pneumatic lift for dilute phase transporting said solid particles.

31. (Original) The desulfurization unit of claim 25, wherein said third transport assembly comprises a close-coupling conduit extending from said

reducer solids outlet to said reactor solids inlet, wherein said close-coupling conduit defines a substantially straight open passageway extending from said reducer solids outlet to said reactor solids inlet.

32. (Original) The desulfurization unit of claim 31, wherein said open passageway extends from said reducer solids outlet to said reactor solids inlet at a downward angle in the range from about 15 to about 75 degrees from horizontal.

33. (Original) The desulfurization unit of claim 32, wherein said reactor solids inlet and said reducer solids outlet are spaced less than about 10 feet from one another, wherein the minimum flow area of said open passageway is at least about 10 square inches.

34. (Original) The desulfurization unit of claim 25, wherein said first transport assembly includes a reactor stripper having a stripper solids inlet and a stripper solids outlet, a reactor lockhopper having a reactor lockhopper solids inlet and a reactor lockhopper solids outlet, and a regenerator feed surge vessel having a surge vessel solids inlet and a surge vessel solids outlet, wherein said first transport assembly is configured to allow for sequential flow of said solid particles from said reactor, to said reactor stripper, to said reactor lockhopper, to said regenerator feed surge vessel, and to said regenerator.

35. (Original) The desulfurization unit of claim 34, wherein said reactor solids outlet is vertically positioned at least as high as said stripper solids inlet.

36. (Original) The desulfurization unit of claim 34, wherein said reactor lockhopper solids inlet is vertically positioned lower than said stripper solids

outlet, wherein said surge vessel solids inlet is vertically positioned lower than said reactor lockhopper solids outlet.

37. (Original) The desulfurization unit of claim 36, wherein said regenerator solids inlet is vertically positioned higher than said surge vessel solids outlet.

38. (Original) The desulfurization unit of claim 37, wherein said first transport assembly includes a pneumatic lift for dilute phase transporting said solid particles upward to said regenerator solids inlet.

39. (Original) The desulfurization unit of claim 25, said second transport assembly including a regenerator receiver having a receiver solids inlet and a receiver solids outlet and a regenerator lockhopper having a regenerator lockhopper solids inlet and a regenerator lockhopper solids outlet, wherein said second transport assembly is configured to allow for sequential flow of said solid particles from said regenerator, to said regenerator receiver, to said regenerator lockhopper, and to said reducer.

40. (Original) The desulfurization unit of claim 39, wherein said regenerator solids outlet is vertically positioned at least as high as said receiver solids inlet.

41. (Original) The desulfurization unit of claim 39, wherein said regenerator lockhopper solids inlet is vertically positioned lower than said receiver solids outlet, wherein said reducer solids inlet is vertically positioned lower than said regenerator lockhopper solids outlet.

42. (Original) A desulfurization unit employing fluidizable and circulatable solid particles to remove sulfur from a hydrocarbon-containing feed, said desulfurization unit comprising:

a reactor for contacting said hydrocarbon-containing feed with said solid particles;

a reactor stripper fluidly coupled to said reactor and operable to receive said solid particles from said reactor;

a reactor lockhopper fluidly coupled to said reactor and vertically positioned lower than said reactor stripper so as to allow for gravity flow of said solid particles from said reactor stripper to said reactor lockhopper;

a regenerator feed surge vessel fluidly coupled to said reactor lockhopper and vertically positioned lower than said reactor lockhopper so as to allow for gravity flow of said solid particles from said reactor lockhopper to said regenerator feed surge vessel; and

a regenerator fluidly coupled to said regenerator feed surge vessel and operable to receive said solid particles from said regenerator feed surge vessel.

43. (Original) The desulfurization unit of claim 42, further comprising a pneumatic lift for dilute phase transporting said solid particles upward to said regenerator.

44. (Original) The desulfurization unit of claim 42, wherein said reactor stripper is close-coupled to said reactor.

45. (Original) The desulfurization unit of claim 42, further comprising a regenerator receiver fluidly coupled to said regenerator and operable to receive said solid particles from said regenerator, a regenerator lockhopper fluidly coupled to said regenerator receiver and vertically positioned lower than said regenerator receiver so as to allow for gravity flow of said solid particles from said regenerator receiver to said regenerator lockhopper, and a reducer fluidly coupled to said regenerator lockhopper and vertically positioned lower than said regenerator lockhopper so as to allow for gravity flow of said solid particles from said regenerator lockhopper to said reducer, wherein said reactor is fluidly coupled to said reducer and operable to receive said solid particles from said reducer.

46. (Original) The desulfurization unit of claim 45, wherein said reducer is close-coupled to said reactor.

47. (Original) The desulfurization unit of claim 46, wherein said regenerator receiver is close-coupled to said regenerator.

48. (Original) A method of desulfurizing a hydrocarbon-containing fluid, said method comprising the steps of:

(a) contacting said hydrocarbon-containing fluid with solid particles in a desulfurization zone under desulfurization conditions sufficient to remove sulfur from said hydrocarbon-containing fluid and provide sulfur-loaded solid particles;

(b) contacting said sulfur-loaded solid particles with an oxygen-containing regeneration stream in a regeneration zone under regeneration

conditions sufficient to remove sulfur from said sulfur-loaded solid particles, thereby providing oxidized solid particles;

(c) contacting said oxidized solid particles with a hydrogen-containing reducing stream in a reducing zone under reducing conditions sufficient to reduce said oxidized solid particles, thereby providing reduced solid particles; and

(d) dense phase transporting said reduced solid particles from said reducing zone to said desulfurization zone.

49. (Original) The method of claim 48, further comprising:

(e) dense phase transporting said oxidized solid particles from said regeneration zone to said reducing zone.

50. (Original) The method of claim 48, further comprising:

(f) contacting said sulfur-loaded solid particles with a stripping fluid in a stripping zone under stripping conditions sufficient to remove said hydrocarbon-containing fluid from around said sulfur-loaded solid particles.

51. (Original) The method of claim 50, further comprising:

(g) simultaneously with steps (a) and (f), dense phase transporting said sulfur-loaded solid particles from said desulfurization zone to said stripping zone through an open passageway.

52. (Original) The method of claim 51, further comprising:

(h) simultaneously with step (g), causing said stripping fluid to flow from said stripping zone to said desulfurization zone through said open passageway.

53. (Original) The method of claim 51, wherein during step (g) the pressure in said stripping zone is maintained within about 10 psi of the pressure in said desulfurization zone.

54. (Original) The method of claim 50, further comprising:

(i) batchwise transporting said sulfur-loaded solid particles from said stripping zone to a reactor lockhopper;

(j) batchwise transporting said sulfur-loaded solid particles from said reactor lockhopper to a regenerator feed surge vessel; and

(k) substantially continuously transporting said sulfur-loaded solid particles from said regenerator feed surge vessel to said regenerator.

55. (Original) The method of claim 54, wherein step (k) includes dilute phase transporting said sulfur-loaded solid particles.

56. (Original) The method of claim 55, wherein steps (i) and (j) are accomplished via gravity flow.

57. (Original) The method of claim 48, further comprising:

(l) contacting said oxidized solid particles with a cooling fluid in a cooling zone under cooling conditions sufficient to cool said oxidized solid particles.

58. (Original) The method of claim 57, wherein step (l) includes removing sulfur dioxide from around said oxidized solid particles.

59. (Original) The method of claim 57, further comprising:

(m) simultaneously with steps (b) and (l), dense phase transporting said sulfur-loaded solid particles from said regeneration zone to said cooling zone through a first open passageway.

60. (Original) The method of claim 59, further comprising:

(n) simultaneously with step (m), causing said cooling fluid to flow from said cooling zone to said regeneration zone through a second open passageway, wherein said first and second open passageways are spaced from one another.

61. (Original) The method of claim 59, wherein during step (m) the pressure in said cooling zone is maintained within about 10 psi of the pressure in said regeneration zone.

62. (Original) The method of claim 57, further comprising:

(o) batchwise transporting said oxidized solid particles from said cooling zone to a regenerator lockhopper; and

(p) batchwise transporting said oxidized solid particles from said regenerator lockhopper to said reducer.

63. (Original) The method of claim 62, wherein steps (o) and (p) are accomplished via gravity flow.

64. (Original) The method of claim 48, wherein step (a) includes contacting said hydrocarbon-containing fluid with a fluidized bed of said solid particles, wherein step (b) includes contacting said oxygen-containing regeneration stream with a fluidized bed of said sulfur-loaded solid particles, wherein step (c)

includes contacting said hydrogen-containing reducing stream with a fluidized bed of said oxidized solid particles.

65. (Original) The method of claim 48, wherein said desulfurization conditions, said regeneration conditions, and said reducing conditions each include a superficial velocity of less than about 10 feet per second.

66. (Original) The method of claim 48, wherein steps (a) through (b) are carried out simultaneously.

67. (Original) The method of claim 48, wherein during step (d), the pressure in said desulfurization zone is maintained within about 10 psi of the pressure in said reducing zone.

68. (Original) The method of claim 48, wherein said desulfurization conditions include a weighted hourly space velocity in the range of from about 0.1 to about 10.

69. (Original) The method of claim 48, wherein said solid particles comprise zinc oxide and a promoter metal component.

70. (Original) The method of claim 68, wherein said promoter metal component comprises a promoter metal selected from the group consisting of nickel, cobalt, iron, manganese, tungsten, silver, gold, copper, platinum, zinc, tin, ruthenium, molybdenum, antimony, vanadium, iridium, chromium, palladium, and combinations thereof.

71. (Original) The method of claim 70, wherein said promoter metal is nickel.

72. (Original) The method of claim 70, wherein said promoter metal component is a substitutional solid solution of said promoter metal and zinc.

73. (Original) The method of claim 69, wherein step (a) includes converting at least a portion of said zinc oxide to zinc sulfide.

74. (Original) The method of claim 73, wherein step (b) includes converting at least a portion of said zinc sulfide to zinc oxide.

75. (Original) The method of claim 74, wherein step (b) includes oxidizing said promoter metal component.

76. (Original) The method of claim 75, wherein step (c) includes reducing said oxidized promoter metal component.

77. (Original) The method of claim 48, wherein said solid particles have a mean particle size in the range of from about 20 to about 150 microns.

78. (Original) The method of claim 48, wherein said solid particles have a Group A Geldart classification.

79. (Original) A method of desulfurizing a hydrocarbon-containing fluid, said method comprising the steps of:

(a) contacting said hydrocarbon-containing fluid with solid particles in a fluidized bed reactor under desulfurization conditions sufficient to remove sulfur from said hydrocarbon-containing fluid and provide sulfur-loaded solid particles;

(b) contacting said sulfur-loaded solid particles with an oxygen-containing regeneration stream in a fluidized bed regenerator under conditions

sufficient to remove sulfur from said sulfur-loaded solid particles, thereby providing oxidized solid particles;

(c) dense phase transporting said oxidized solid particles from said fluidized bed regenerator to a fluidized bed reducer; and

(d) contacting said oxidized solid particles with a hydrogen-containing reducing stream in said fluidized bed reducer under reducing conditions sufficient to reduce said oxidized solid particles, thereby providing reduced solid particles.

80. (Original) The method of claim 79, wherein step (c) is accomplished via gravity flow.

81. (Original) The method of claim 79, wherein said reducer is close-coupled to said reactor.

82. (Original) The method of claim 79, wherein steps (a) through (d) are carried out simultaneously.

83. (Original) The method of claim 79, further comprising:

(e) dense phase transporting said sulfur-loaded solid particles from said reactor to a regenerator feed surge vessel; and

(f) dilute phase transporting said sulfur-loaded solid particles between said regenerator feed surge vessel and said regenerator.

84. (Original) The method of claim 83, wherein step (e) includes dense-phase transporting said sulfur-loaded solid particles from a reactor stripper to a reactor lockhopper, wherein said reactor stripper is close-coupled to said reactor.

85. (Original) The method of claim 84, wherein step (e) is accomplished via gravity flow.

86. (Original) The method of claim 79, wherein step (c) includes dense phase transporting said oxidized solid particles from a regenerator receiver to a regenerator lockhopper, wherein said regenerator receiver is close-coupled to said regenerator.

87. (Original) A method of desulfurizing a hydrocarbon-containing fluid, said method comprising the steps of:

(a) contacting said hydrocarbon-containing fluid with solid particles in a desulfurization zone under desulfurization conditions sufficient to remove sulfur from said hydrocarbon-containing fluid and provide sulfur-loaded solid particles;

(b) contacting said sulfur-loaded solid particles with a stripping gas in a stripping zone under stripping conditions sufficient to remove said hydrocarbon-containing fluid from around said sulfur-loaded solid particles;

(c) batchwise transporting said sulfur-loaded solid particles from said stripping zone to a reactor lockhopper;

(d) batchwise transporting said sulfur-loaded solid particles from said reactor lockhopper to a regenerator surge feed vessel;

(e) substantially continuously transporting said sulfur-loaded solid particles from said regenerator feed surge vessel to a regeneration zone; and

(f) contacting said sulfur-loaded solid particles with an oxygen-containing regeneration stream in said regeneration zone under regeneration conditions sufficient to remove sulfur from said sulfur-loaded solid particles, thereby providing oxidized solid particles.

88. (Original) The method of claim 87, further comprising:

(g) dense phase transporting said sulfur-loaded solid particles from said desulfurization zone to said stripping zone.

89. (Original) The method of claim 88, wherein step (e) includes dilute phase transporting said sulfur-loaded solid particles to said regeneration zone.

90. (Original) The method of claim 87, further comprising:

(h) contacting said oxidized solid particles with a hydrogen-containing reducing stream in a reducing zone under reducing conditions sufficient to reduce said oxidized solid particles, thereby providing reduced solid particles.

91. (Original) The method of claim 90, further comprising:

(i) batchwise transporting said reduced solid particles from said reducing zone to said desulfurization zone.

92. (Original) The method of claim 91, wherein step (i) is carried out while maintaining said reduced solid particles in dense phase.

93. (Original) The method of claim 90, further comprising:

(j) contacting said oxidized solid particles with a cooling gas in a cooling zone under cooling conditions sufficient to cool said oxidized solid particles.

94. (Original) The method of claim 93, further comprising:

(k) substantially continuously transporting said oxidized solid particles from said regeneration zone to said cooling zone.

95. (Original) The method of claim 94, further comprising:

(l) batchwise transporting said oxidized solid particles from said cooling zone to a regenerator lockhopper; and

(m) batchwise transporting said oxidized solid particles from said regenerator lockhopper to said reducing zone.

96. (Original) The method of claim 95, wherein steps (k), (l), and (m) are carried out while maintaining said oxidized solid particles in dense phase.